CLAIMS

1. A kneading status evaluation method for a rubber composition (I) containing at least a rubber (A) and a filler (B), which comprises the steps of;

(1) a complex modulus measurement step to measure a complex modulus of E*(a) at a given strain εa and a complex modulus E*(b) at a given strain εb differing from the strain εa,

(2) a filler dispersion index calculation step to calculate a filler dispersion index (N) of the rubber composition (I) according to the following equation;

$$\text{Filler dispersion index (N)} = |E^*(a)|/|E^*(b)|$$

where complex elastic moduli E*(a) and E*(b) are obtained at the complex modulus measurement step (1), and

(3) a comparison step to compare a predetermined target filler dispersion index (R) with the filler dispersion index (N) calculated in the filler dispersion index calculation step (2).

2. The evaluation method as claimed in claim 1, wherein the target filler dispersion index (R) is a complete target filler dispersion index (N0) obtained through the complex modulus measurement step (1) and the filler dispersion index calculation step (2) after a rubber composition having the same formulation as that of the rubber composition (I) is substantially kneaded

to achieve a practically complete dispersion.

3. The evaluation method as claimed in claim 2, wherein the practically complete dispersion is achieved by kneading with an open roll mill.

4. A kneading status evaluation method for a rubber composition (I) containing at least a rubber (A) and a filler (B), which comprises the steps of;

(1′) a dynamic elastic modulus measurement step to measure a dynamic elastic modulus E′(a) at a given strain ε a and a dynamic elastic modulus E′(b) at a given strain ε b differing from the strain ε a,

(2′) a filler dispersion index calculation step to calculate a filler dispersion index (N′) of the rubber composition (I) according to the following equation;

$$\text{Filler dispersion index (N')} = E'(a)/E'(b)$$

where the dynamic elastic moduli E′(a) and E′(b) are obtained at the dynamic elastic modulus measurement step (1′), and

(3′) a comparison step to compare a predetermined target filler dispersion index (R′) with the filler dispersion index (N′) calculated in the filler dispersion index calculation step (2′).

5. The evaluation method as claimed in claim 4, wherein the

target filler dispersion index (R') is a complete target filler dispersion index (N0') obtained through the dynamic elastic modulus measurement step (1') and the filler dispersion index calculation step (2') after a rubber composition having the same formulation as that of the rubber composition (I) is substantially kneaded to achieve a practically complete dispersion.

6. The evaluation method as claimed in claim 5, wherein the practical complete dispersion is achieved by kneading with an open roll mill.

7. A manufacturing method for a rubber composition utilizing the kneading status evaluation methods for a rubber composition according to any one of claims 1 to 6.

8. The manufacturing method for a rubber composition as claimed in claim 7, which further comprises a feedback step (4) or (4') to control kneading conditions of the rubber composition (I) by means of adjusting a value of filler dispersion index (N)/target filler dispersion index (R) to be a certain numeric range, or a value of filler dispersion index (N')/target filler dispersion index (R') to be a certain numeric range according to the result from the comparison

step (3) or (3').

9. The manufacturing method for a rubber composition as claimed in claim 8, wherein the numeric range of the value of filler dispersion index (N)/target filler dispersion index (R) (where $|E^*(a)| \leqq |E^*(b)|$) or the value of filler dispersion index (N')/target filler dispersion index (R') is 0.8 to 1.0.

10. A kneading status evaluation method for a rubber composition (I) containing at least a rubber (A) and a filler (B), which comprises the steps of:

(5) a complex viscosity coefficient measurement step to measure a complex viscosity coefficient η^* of the rubber composition (I) under at least two different temperatures,

(6) a kneading status monitor index calculation step to calculate a kneading status monitor index (M) of the rubber composition (I) according to the following equation;

$$|\eta^*(T)| = A \exp(-M/RT)$$

where η^*: complex viscosity coefficient, A: proportional constant, R: gas constant, and T: measuring temperature (°K), that shows a temperature dependency of the complex viscosity coefficient η^* obtained at the complex viscosity coefficient measurement step (5), and

(7) a comparison step to compare a predetermined target

kneading status monitor index (P) with the kneading status monitor index (M) calculated in the kneading status monitor index calculation step (6).

11. The evaluation method as claimed in claim 10, wherein the target kneading status monitor index (P) is a complete target kneading status monitoring index (M0) obtained through the complex viscosity coefficient measurement step (5) and the kneading status monitor index calculation step (6) after a rubber composition having the same proportion as that of the rubber composition (I) is substantially kneaded to achieve a practically complete dispersion.

12. The evaluation method as claimed in claim 11, wherein the practically complete dispersion is achieved by kneading with an open roll mill.

13. A kneading status evaluation method for a rubber composition (I) containing at least a rubber (A) and a filler (B), which comprises the steps of:

(5') a viscosity coefficient measurement step to measure a real viscosity coefficient η' as a real part of complex viscosity coefficient η^* of the rubber composition (I) under at least two different temperatures,

(6′) a kneading status monitor index calculation step to calculate a kneading status monitor index (M′) of the rubber composition (I) according to the following equation;

$$\eta'(T) = A \exp(-M'/RT)$$

where A: proportional constant, R: gas constant, and T: measuring temperature (°K),

that shows a temperature dependency of a real viscosity coefficient η' obtained as a real part of complex viscosity coefficient η^* at the viscosity coefficient measurement step (5′), and

(7′) a comparison step to compare a predetermined target kneading status monitor index (P′) with the kneading status monitor index (M′) obtained in the kneading status monitor index calculation step (6′).

14. The evaluation method as claimed in claim 13, wherein the target kneading status monitor index (P′) is a complete target kneading status monitor index (M0′) obtained through the viscosity coefficient measurement step (5′) and the kneading status monitor index calculation step (6′) after a rubber composition having the same formulation as that of the rubber composition (I) is substantially kneaded to achieve a practically complete dispersion.

15. The evaluation method as claimed in claim 14, wherein the practical complete dispersion is achieved by kneading with an open roll mill.

16. A manufacturing method for a rubber composition utilizing the kneading status evaluation methods for a rubber composition according to any one of claims 10 to 15.

17. The manufacturing method for a rubber composition as claimed in claim 16, which further comprises a feedback step (8) or (8') to control kneading conditions of the rubber composition (I) by means of adjusting a value of kneading status monitor index (M)/target kneading status monitor index (P) to be a certain numeric range, or a value of kneading status monitor index (M')/target kneading status monitor index (P') to be a certain numeric range according to the result from the comparison step (7) or (7').

18. The manufacturing method for a rubber composition as claimed in claim 17, wherein the numeric range of the value of kneading status monitor index (M)/target kneading status monitor index (P) or the value of kneading status monitor index (M')/target kneading status monitor index (P') is 0.85 to 1.0.